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DUAL SPRAY EQUIPMENT FOR AIRPLANE SPRAYING TESTS

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For several years the Bureau of Entomology and Plant Quarantine, in cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering, has been developing and testing aerial spray equipment for use in controlling forest-insect pests. The principal objective of this work has been to develop a system that will distribute a uniform deposit of properly atomized spray over a swath of maximum width. In addition to the problems involved in the design and construction of this equipment, it has been difficult to devise a method of evaluating its performance, or of comparing the effectiveness of various arrangements of its parts, of different pump pressures, or of different insecticide formulations.

The performance of an aerial spray system is governed by many factors, not all of which are controllable. The controllable factors include type of nozzle or discharge orifice, position of the orifice, pressure exerted on the spray, and insecticide formulation. The uncontrollable factors include direction and velocity of the wind, temperature and humidity, and convection, inversion, and turbulence of the air. To determine the most satisfactory nozzle to use, its correct position, or the proper pressure, it is necessary to hold the remaining factors constant. For wind direction and velocity this is practically impossible.

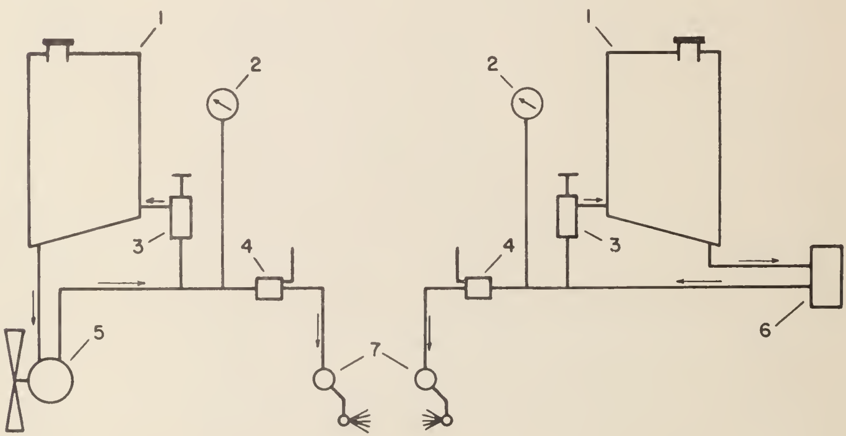
The method used in the past to evaluate performance has been to fly the plane directly into the wind while liberating spray over the center of lines laid out at right angles to the line of flight, collect samples of spray deposit at regular intervals along these lines, and determine the quantity by laboratory methods. Despite efforts to fly the plane directly into the wind, slight shifts in wind direction while the plane was passing over the sample lines frequently caused drifting of the spray. It was not unusual for the wind to affect the deposit pattern to a greater extent than changes in type or arrangement of equipment.

This paper describes the construction and installation of an aerial spray apparatus with which various types and arrangements of spray nozzles, pressures, and insecticide formulations can be tested under

identical meteorological conditions. Its use permits a direct comparison of the effect of any of these factors on spray dispersal. While it does not eliminate the need for replicating test flights, it does provide a simultaneous check flight for each test. This apparatus consists of two complete spray systems, each consisting of a tank, pump, boom, and control accessories mounted on a single plane.

Equipment

The equipment used in constructing this dual spray system is a modification of previously described equipment (U. S. Bur. Plant Indus., Soils, and Agr. Engin., Inform. Ser. 87), and it has been installed in a Stearman N2S5 airplane. The layout of the two systems is shown in figure 1.



1. Tank
2. Pressure gage
3. Pressure regulator
4. Shut-off valve
5. Centrifugal pump, wind-driven
6. Gear pump, engine-driven
7. Boom and nozzle

Figure 1. --Schematic diagram of dual spray units.

Two spray tanks (1) are located in the front cockpit, one in the space normally occupied by the front seat and the other immediately behind the fire wall. A wind-driven 1 1/4-by 1-inch centrifugal pump (5) is used in one system and an engine-driven gear pump(6) of the same size in the other. The gear pump is used to produce higher pressures in tests of the effect of pump pressure on spray dispersal. The centrifugal pump is mounted between the landing-gear struts and the gear pump on the generator pad of the aircraft engine.

Both systems are equipped with adjustable pressure regulators (3) in order that desired spray pressures can be maintained uniformly. Each system is equipped with an emergency dump valve located in the tank outlet line (not shown in fig. 1), and in both the spray-control valves (4) are of the quick-opening gate type. Controls for pressure regulators, spray control valves, and dump valves are located in the cockpit, within easy reach of the pilot.

Each spray system has its own boom. They are mounted one immediately behind the other, approximately 9 inches below the lower surface of the lower wing, and they extend from wing tip to wing tip (fig. 2 and 3). The inboard half of each boom consists of 1 1/8-inch tubing, the outboard half of 1-inch tubing. It will be noted in figure 2 that the boom outlets are directed downward and to the rear at an angle of 45°. Short nipples and 45° elbows are used for attachment of the nozzles. This arrangement prevents the spray from wetting the booms when tangential-type hollow-cone spray nozzles are used with the orifices directed either forward or backward. Variations in orifice direction are obtained by rotating the booms on their long axes or by changing the fittings.

Performance

Results of tests with this dual spray system indicate that it is a distinct improvement over earlier systems. No longer is it necessary, for instance, to attempt the well-nigh impossible task of duplicating meteorological conditions in successive test flights to compare performances of various nozzles, nozzle positions, and pump pressures.

Comparisons of performances between the two systems can be made by using different dyes in the liquids of the two systems. For accurate comparisons there must be little or no combining of the drops from one system with those from the other while the spray is falling through the air. Tests have shown that there is very little such combining of drops. The quantity of spray delivered by each system at any point in the swath is determined by the use of a sensitive spectrophotometer. To record the quantity of the two dyes on the sample, it is only necessary to expose the sample to two different specific wave lengths. The quantity of spray deposited by each system at any station can be calculated from the quantity of dye recorded by this means.

Figure 2. --Details of attachment of dual spray booms and nozzles.

Figure 3. --Stearman airplane with dual spray equipment.